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# REAL TIME FAULT DETECTION OF HVAC SYSTEMS BY A STATE SPACE MODEL

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## Abstract

Malfunctions or faults of HVAC systems should be detected as soon as possible, however, the detection is often delayed and sometimes systems are operated without awareness of fault occurrence. On of the reasons of the problems is in the sophistication of recent HVAC systems, that makes a system intangible or a black-box to maintenance stuffs. In the present paper a method of real time fault detection (FD) based on a state space model is proposed. According to our investigation it was found that the performance and the sensitivity of the present method is satisfactorily high because the FD is not based on the simple limit checker algorithm but on the dynamic response of the subsystem of a HVAC system.

## 1: Introduction

In common HVAC systems, highly reliable operation or less possibility of malfunction occurrence is not taken as an important issue. Only specific types of facilities, such as a space for telecommunication systems or mainframe computers to process bank business, and a laboratory to handle radioactive materials, etc., are exceptions that require reliable operation in order to avoid substantial economic and social losses.

This is because the main purpose of common HVAC systems is in offering human comfort, and malfunction of the system brings not so serious damages as those of the facilities mentioned above. Although occupants will complain about the undesirable thermal environment due to malfunctions, they are generally reconciled to it and reluctantly wait for the system's recover. According to the results of a questionnaire survey occupants can wait for 30 to 60 minutes without much complain [1]. This concludes that fast detection of a fault and prompt fixing of it are more important than the reliable operation in common HVAC systems.

According to the recognition development of an automated and real time fault detection systems is recommended. One of the prominent possibilities for implementing the system is in using the surplus power of existing computers for HVAC control system or building energy management system (BEMS). The needs and generic methods are widely assessed in the report of Annex 25, International Energy Agency [2]. Nevertheless the present fault detection method implemented is mostly based on the simple limit checker, which detects a fault by checking whether a state exceeds a threshold or not.

If a system is activating dynamically, a fault can be detected by comparing the observed dynamic response and those generated by the dynamic system model. In the present study a fault detection method of a subsystem, which is made up with a cooling coil of an air handling unit, a PI controller and a control valve of water, is proposed and tested. The fault detection method based on dynamic response is reported in many fields [3], [4], however, in the field of HVAC engineering the study is very limited [5].

## 2: Method